

<i>School</i>	<i>Candidate's Name (PLEASE PRINT)</i>
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WINCHESTER
COLLEGE

WINCHESTER ELECTION

Chemistry Examination

2024

PRACTICAL SECTION

Recommended time: 45 minutes

*You will be given **three minutes** to read the paper and check you have the correct equipment*

Total marks: 50

*Candidates will be awarded up to four marks for using appropriate practical skills
whilst handling chemicals*

Write all your answers in the spaces on this question paper

CALCULATORS MAY BE USED

WEAR EYE PROTECTION (PROVIDED)

PLEASE REPORT SPILLAGES OR ACCIDENTS

ANY SOLUTIONS SPILT ON THE SKIN SHOULD BE RINSED OFF UNDER COLD WATER

Apparatus and Reagent list:

One test-tube rack of boiling tubes already filled with reagents A-E

A PH meter sitting in its own boiling tube of water

One test-tube rack containing 4 empty boiling tubes

A beaker for collecting water and any waste solution in

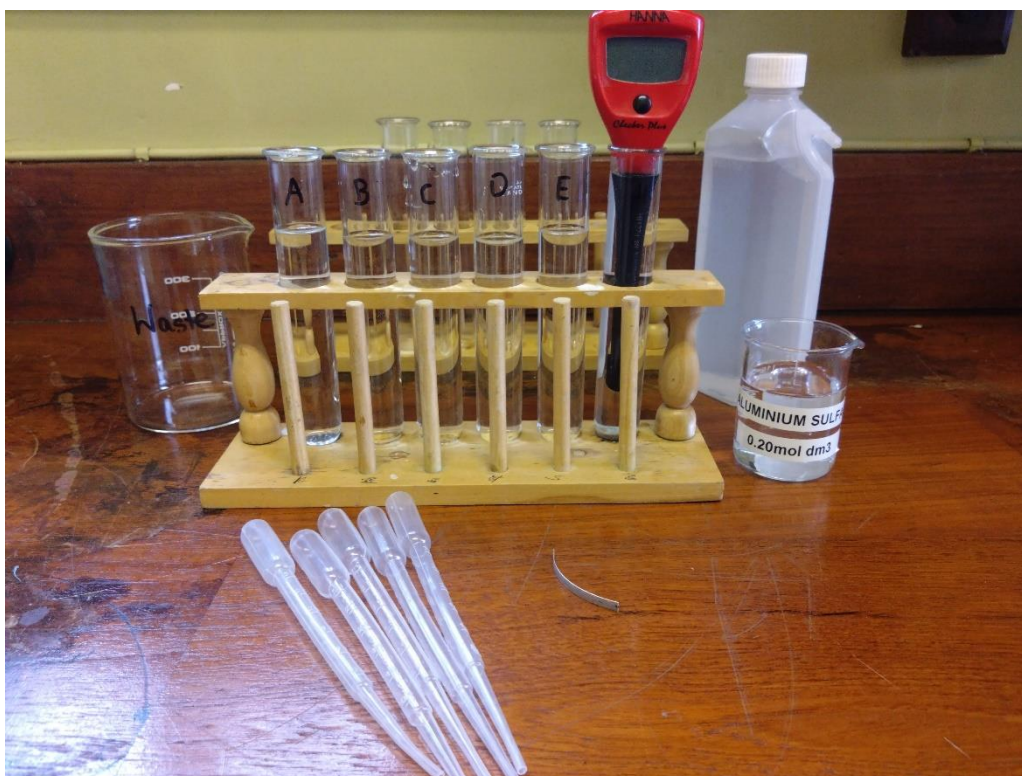
A beaker of 0.2 mol dm⁻³ aluminium sulfate solution

5 Droppers

A short strip of magnesium ribbon

One wash bottle

A picture of your practical work space (the exact levels of the liquids are not important):



When using the pH probe:

- Rinse the probe tip gently with a little water from the wash bottle. Use the waste beaker to catch the water used.
- Wait approximately 10 seconds before taking a pH reading once the meter is placed into the solution being tested. If the meter reading is not steady at the moment you take it, simply record the value anyway and label the value in the table with a star.
- Remove the probe, rinse with a little water, and replace it in its own boiling tube.

Q1 You have 5 solutions labelled A, B, C, D, and E in boiling tubes.

You also have a rack containing empty boiling tubes.

(a) Use a dropper to add approximately 1 cm height of solution D to each of four empty boiling tubes in the other boiling tube rack.

(i) To the first boiling tube, add 4 drops of solution A. Note your observations, then add a further 3 cm depth of solution A, shake gently to mix, and note your observations.

After 4 drops.....

.....

After 3 cm more.....

.....

[3]

(ii) To the second boiling tube, add 4 drops of solution B. Note your observations, then add approximately a further 3 cm depth of solution B, shake gently to mix, and note your observations.

After 4 drops.....

.....

After 3 cm more.....

.....

[3]

(iii) To the third boiling tube, add 4 drops of solution C. Note your observations, then add approximately a further 3 cm depth of solution C, shake gently to mix, and note your observations.

After 4 drops.....

.....

After 3 cm more.....

.....

[3]

- (iv) To the fourth boiling tube, add 4 drops of solution E. Note your observations, then add approximately a further 3 cm depth of solution E, shake gently to mix, and note your observations.

After 4 drops.....

.....

After 3 cm more.....

.....

[3]

- (b) Switch on the pH probe and check that the reading in the boiling tube of water is between 6 and 8. Ask for help if the reading is outside this range.

Now rinse the pH meter and use it to test the pH of each of the five solutions, A to E, in their boiling tubes. Rinse the pH meter between measurements.

A reminder: Wait approximately 10 seconds before taking a pH reading once the meter is placed into the solution being tested.

Record the pH values in the table below and for each of solutions A-E suggest the colour that universal indicator would turn, given the pH reading.

solution	pH	colour of universal indicator at this pH
A		
B		
C		
D		
E		

[6]

Now rinse out these five boiling tubes into your waste beaker using the wash bottle and replace the tubes in the rack. These boiling tubes will be used again in Question 2.

Q2 In the next part of the practical test you will record the pH of an aluminium sulfate solution at several different concentrations by diluting a stock sample. **Concentration** is a measure of how much of a substance is dissolved in a given volume of solvent. Concentration has units of mol dm^{-3} . **Dilution** is the mixing of a solution with more solvent to lower the concentration, since the same amount of solute is now dissolved in a larger volume of solvent.

You have been provided with a measuring cylinder of 25 cm^3 ($= 25 \text{ ml}$) to allow you to measure out volumes of solution and/or water. You should use the beaker of 0.20 mol dm^{-3} aluminium sulfate solution for this part of the practical.

(a) Fill in the table on the following page, by preparing solutions, and measuring the pHs, as instructed below.

- Transfer 15 cm^3 of 0.20 mol dm^{-3} aluminium sulfate solution into a boiling tube. Rinse the pH probe and measure the pH of your sample. Record your pH value in the table.
- To make the measurement at a concentration of 0.10 mol dm^{-3} , measure out 15 cm^3 of 0.20 mol dm^{-3} aluminium sulfate solution and 15 cm^3 of water into the same boiling tube. Now rinse the pH probe and measure the pH of this mixture. Record your pH value.
- Using a mixture of 0.20 mol dm^{-3} aluminium sulfate solution with water in another boiling tube, prepare a solution with a concentration of $0.050 \text{ mol dm}^{-3}$. Measure and record the pH of this $0.050 \text{ mol dm}^{-3}$ solution as before.

Describe here how you made this $0.050 \text{ mol dm}^{-3}$ solution.

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- To prepare the solution with concentration $0.020 \text{ mol dm}^{-3}$, measure out 5 cm^3 of your 0.10 mol dm^{-3} solution and mix it with 20 cm^3 of water in a boiling tube. Measure and record its pH.
- For the final (blank) row in the table, take 5 cm^3 of the original 0.20 mol dm^{-3} aluminium sulfate solution and mix it with 20 cm^3 of water in a clean boiling tube and measure its pH. Fill in the whole of the last row of the table.

Concentration of aluminium sulfate / mol dm^{-3}	pH
0.20	
0.10	
0.050	
0.020	

[4]

(b) Tick the correct responses in the tables:

The solution of aluminium sulfate in water is

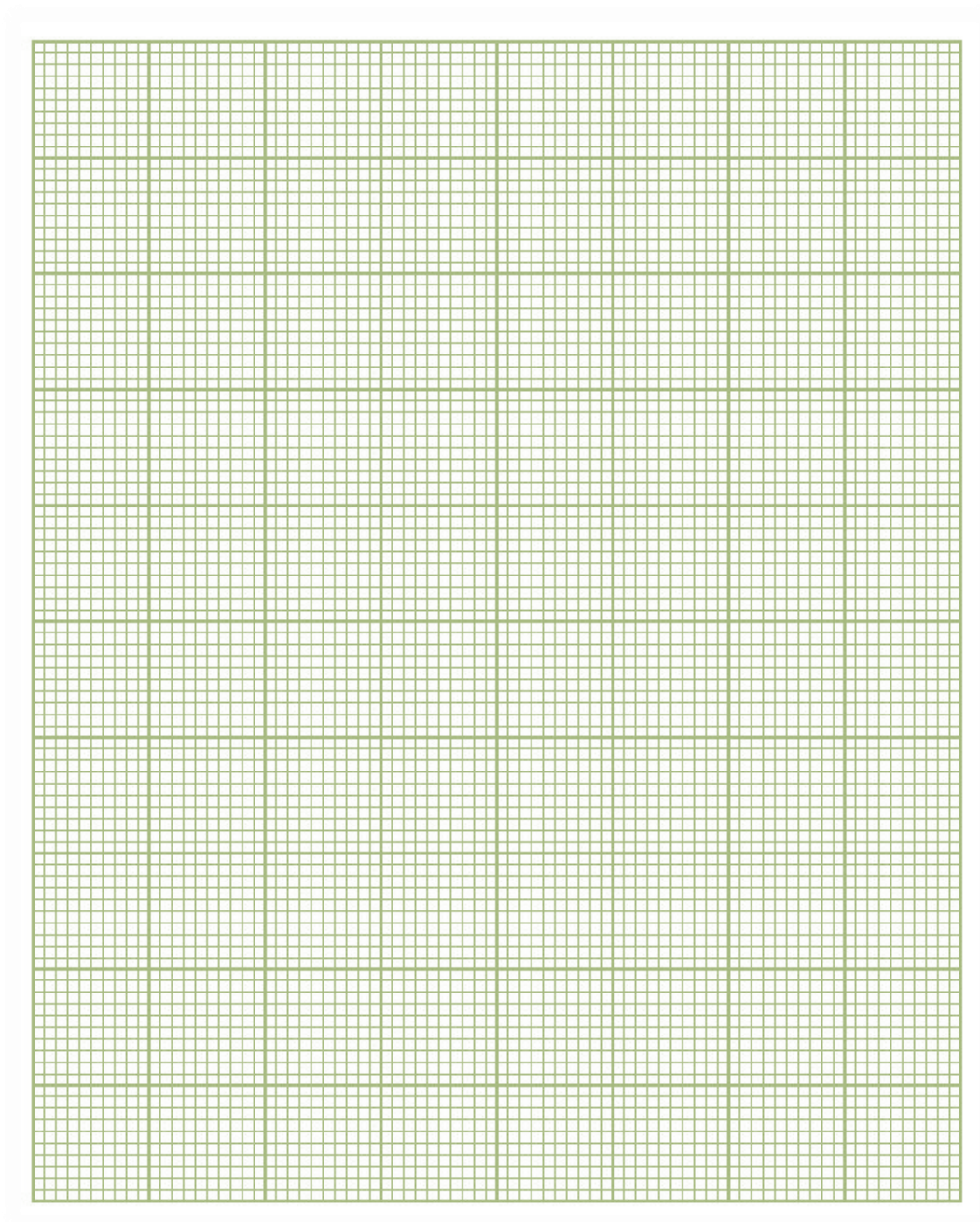
acidic	
alkaline	
neutral	

As the concentration of aluminium sulfate decreases, the pH

decreases	
increases	
stays the same	

[2]

- (c) Use the graph paper below and the data recorded in your table on the previous page, plot a graph of pH against concentration for aluminium sulfate. Draw a smooth curve to fit your data.



[7]

- (d) Showing your working on your graph, predict the pH of a solution of aluminium sulfate at a concentration of $0.080 \text{ mol dm}^{-3}$.

.....

[2]

Q3 Aluminium sulfate has the chemical formula $\text{Al}_2(\text{SO}_4)_3$, meaning that whatever quantity of aluminium sulfate you have, there are always 3 sulfate ions for every 2 aluminium ions.

- (a) The electric charges on the aluminium and the sulfate cancel out such that the total charge for the compound, as a whole, is zero. The charge on each sulfate is -2 . Deduce the charge on each aluminium ion.

.....
.....

[1]

The concentration of the aluminium sulfate solution is 0.20 mol dm^{-3} .
Therefore, in every dm^3 of solution, there are 2.4×10^{23} aluminium ions.

Note that $1.0 \text{ dm}^3 = 1000 \text{ cm}^3$.

- (b) Calculate:
- (i) the number of sulfate ions in 15 cm^3 of the 0.20 mol dm^{-3} aluminium sulfate solution.

.....
.....
.....

[3]

- (ii) the total number of ions in 25 cm^3 of aluminium sulfate at a concentration of $0.050 \text{ mol dm}^{-3}$.

.....
.....
.....

[3]

Q4 Add the strip of magnesium ribbon to the remaining 0.20 mol dm^{-3} aluminium sulfate solution in your beaker.

(a) Give one observation and two conclusions.

Observation:

.....
.....

Conclusions:

.....
.....

[3]

(b) Write the word equation for the expected reaction between aluminium and sulfuric acid.

[2]

End of questions